Development of a strain-based flaw assessment method for defective pipeline girth welds

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I. Introduction

Girth welds are critical for the deformation capacity of steel pipelines. In some conditions (e.g. landslides) these pipelines deform plastically, which may lead to catastrophic failure originating from a girth weld defect.

All detected weld defects should be assessed. Current standard methods are limited in accounting for plasticity. This PhD aims for a new 'strain-based' defect assessment method for plastic problems, supported by finite-element analysis and experiments.

II. Method and results

A recently finalized parametric finite-element model (Figure 1) allows for a strain-based defect assessment. The user can modify weld geometry, defect shape, material properties and loading conditions. Supporting in-house developed software, *CrackSim*, enables evaluation of crack growth. Of particular interest is the role of stress-strain behaviour, oversimplified in current standards. A new stress-strain model [1;2] was developed, giving better descriptions of structural behaviour and crack driving force.

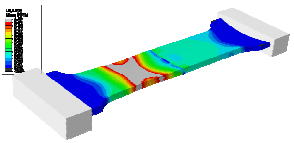

Figure 1: Longitudinal strain distribution in a tensile loaded defective girth weldment.

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To validate the developed model, tensile tests will be performed on samples of defective weldments. A proper analysis will be facilitated by advanced measurement techniques: direct current potential drop (DC-PD) to measure crack growth, and digital image correlation (DIC) to monitor the full-field deformation of the weldment (Figure 2).

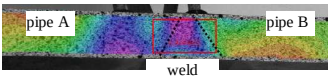

Figure 2: A DIC longitudinal strain measurement on a standard cross weld tensile test.

The results will enable the quantification of influence factors, and provide the basis for simplified assessment equations.

III. Conclusions

The performed work revealed the importance of stress-strain behaviour on the plastic deformation of defective welds, and will provide a simplified weld defect assessment method.

Acknowledgements

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References

[1] Stijn Hertelé, Wim De Waele, Rudi Denys, *Full range stress-strain relation modelling of pipeline steels*, J. Pipeline Eng., 2009.

[2] Stijn Hertelé, Wim De Waele, Rudi Denys, *Determination of full range stress-strain behavior of pipeline steels using tensile characteristics*, Proc. 8th Int. Pipeline Conf., 2010.